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Geometric Control of Patterned Linear Systems

In this talk we present a class of linear control systems called patterned linear systems, where every matrix in the state space representation of the system shares the same set of eigenvectors.

Equivalently, each system matrix is a polynomial function of a common base matrix. This class includes for example, circulant systems, which are systems comprising a closed chain of identical subsystems that are interconnected in a repeated pattern. Some examples of applications of these systems are mobile networks, paper machines, and the approximation of partial differential equations. The control of circulant systems has been studied by previous researchers using the matrix algebra properties of circulant matrices. Our class is broader than just circulants, and we study patterned systems using abstract algebra, specifically the observation that a set of matrices with common eigenvectors has useful relationships with a set of invariant subspaces. The description of the class in terms of subspaces allows these systems to be studied under geometric control theory. In particular, the objective is to find feedback controllers to solve some of the classic problems of geometric control such as the restricted regulator problem, while preserving the pattern of the system. We conclude with a discussion of several applications of the results.